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Bioretention Cells: A Guide for Your Residents

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Meet Your Bioretention Cell

Do you have a shallow, low-lying, and landscaped feature in your community that is mostly dry, except for after rain events? Does this area seem as though it was designed to collect runoff after rainfall, allowing it to infiltrate, or soak, back into the ground over a few days? Is this area vegetated with grass or perhaps a variety of shrubs, flowering plants and small trees? If so, you might have a stormwater best management practice known as a bioretention cell (or rain garden) in your community.

After a storm event, rain that falls onto impervious surfaces like roofs, roads and driveways flows as runoff across the land to storm drains. This stormwater runoff, if unmanaged, can lead to flooding around property, buildings and streets. As runoff flows across land, it picks up the contaminants we leave behind (such as fertilizer, auto fluids, trash, and pet waste), carries it to the storm drain or roadside ditch and ultimately, to the nearest downstream waterway. Unmanaged and polluted stormwater runoff can negatively impact a receiving waterbody, resulting in potential ecological and human health consequences. The US Environmental Protection Agency (US EPA) has identified unmanaged stormwater as a major threat to our nation's waterways.

Figure 1. Bioretention cells in a residential lawn. Note the depressed, shallow basin characteristic of this best management practice. Photo courtesy Mary Caflisch.

To help reduce the impact of stormwater runoff in our communities, best management practices like bioretention cells are used to manage stormwater runoff quantity and quality. Bioretention cells help to:

- Receive and hold runoff generated during small to medium sized storms, allowing it to infiltrate into the ground over a one to three day period.
- Provide some flood storage.
- Filter, trap, and remove contaminants in stormwater runoff that would otherwise be carried downstream. These pollutants include nutrients, heavy metals, harmful bacteria and pathogens, sediment, oils and grease, and other types of organic material (US EPA, 1999; Hunt et al., 2008).

Design Principles of Your Bioretention Cell

Size and shape, soil mix, inlets and outlets, underdrains and plant selection are all important distinguishing characteristics of your bioretention cell.

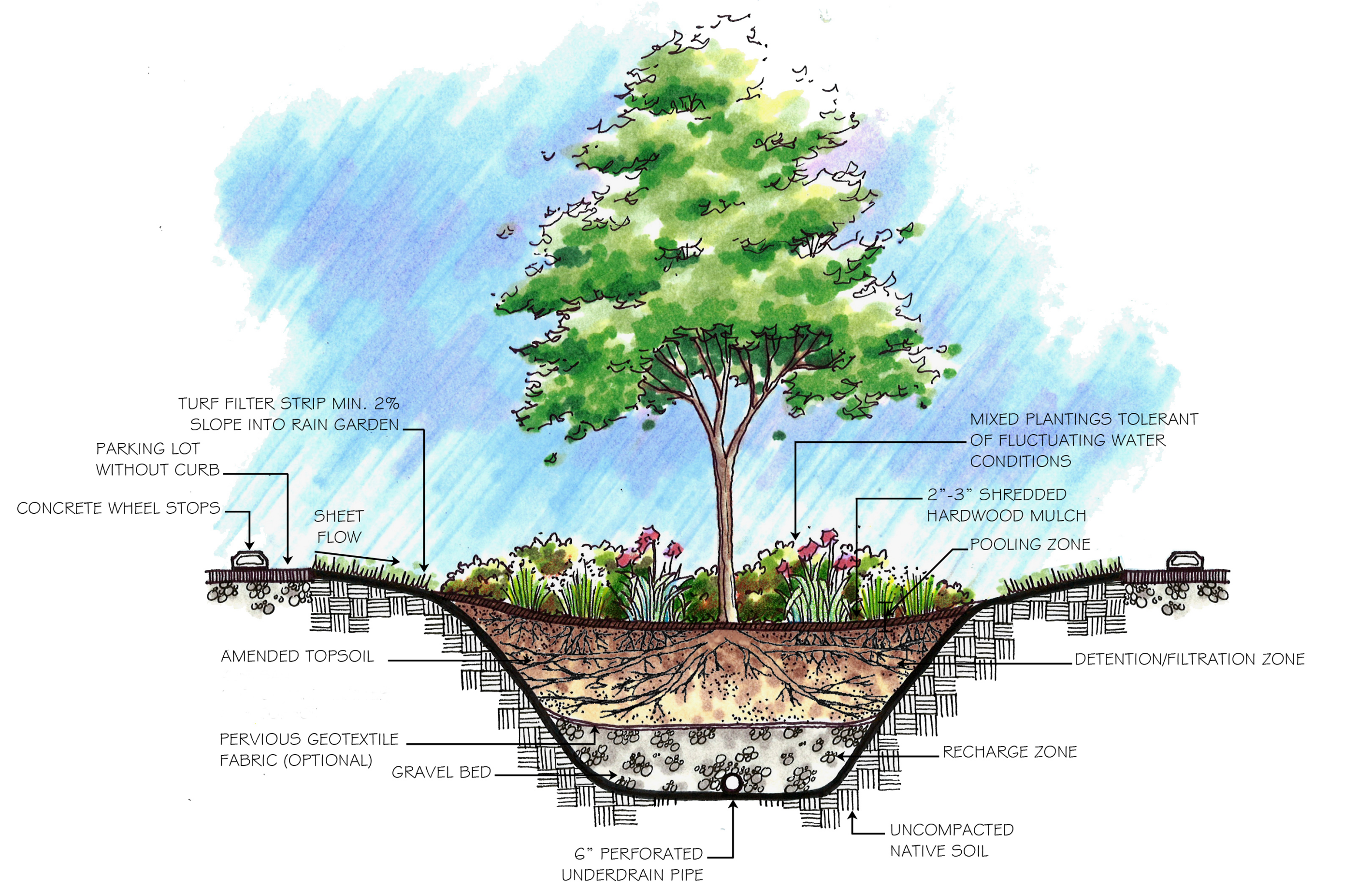

Figure 2. Example of a bioretention cell that may be used in parking lot. This bioretention cell receives runoff as overland flow and an underdrain is used to help the cell manage larger storm events.

Bioretention cell size is dependent on several factors including contributing drainage area, imperviousness of that drainage area, land use, soil type, and more. The greater the drainage area and amount of impervious cover within that drainage area, the larger the bioretention cell size needed. In South Carolina, bioretention cells must have a 10-foot minimum width for healthy plant growth (SC DHEC, 2005).

Bioretention cells receive runoff through inlets, such as a pipe, curb cut, open swales, or as sheet flow. Cells are typically designed to hold and infiltrate runoff produced from small to medium-size storms and are not designed to manage for large storm events and water retention. Some bioretention cells may have an underground pipe system known as an underdrain, which helps facilitate drainage of the cell. To help prevent flooding of the bioretention cell during more frequent or heavier storms, overflow outlets and these underdrains help to convey runoff to another best management practice or the storm drain system.

The soil mix that comprises your bioretention cell was carefully selected and is the critical component for promoting infiltration, as well as supporting plant growth and healthy microbial activity. The soil mix is composed of sand, silt or topsoil, and organic material such as compost or pine bark fines; the ratio of these in the soil mix is specific to the site and was selected to help infiltrate 0.5 inches of water an hour. The clay content of the soil mix is less than 5% (SC DHEC, 2005).

Bioretention cells are planted with grass, shrubs, small trees, or flowering plants that can tolerate both wet and dry conditions. They can look like depressed, shallow turf areas in a lawn, lush landscaped gardens in parking lot medians, a traditional flowerbed or a mixed ornamental planting. Plant selection for your bioretention cell is dependent on many factors including location, secondary uses for the area, wildlife benefits, maintenance, particular pollutant concerns and more.

To find out more information on bioretention cell sizing, design, soil mix and planting requirements, review the *South Carolina DHEC Storm Water BMP Management Field Manual* (2005) and Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al., 2014).

Figure 3. Bioretention cell design, including plant types used, can vary depending on the location and community needs. Top: The bioretention cell located in a small pocket park in Aiken, SC uses turfgrass as its primary type of vegetation. A bridge has been installed to help pedestrians cross over the cell. Bottom: The bioretention cell in the roundabout of this commercial parking lot recieves runoff as flow across the pavement. A combination of shrubs, tall grasses, and small trees are used to landscape. Photo courtesy Bill Lord, NCSU.

Bioretention Cell Purpose in Your Landscape

During small to medium storms, you should expect to see runoff flow into your bioretention cell through sheet flow or through inlet(s), then collect and slowly drawdown (through infiltration, sometimes aided by the underdrain) over a one to three-day period. During larger storms, once your cell fills with runoff, excess collected water will flow through the overflow outlet and downstream. If functioning properly, your bioretention cell should remain dry between storm events.

Multiple biological and geochemical processes occur in your bioretention cell to help mitigate pollutants in stormwater, ultimately protecting our waterways. A few of these are included below:

- As runoff is collected and temporarily stored in your bioretention cell, it is slowed, allowing sediment particles to settle in a process referred to as sedimentation. Sedimentation in bioretention cells not only reduces sediment in runoff but also is an important process for removing pollution, as many types of contaminants are attached to this captured sediment.

- The soil mix plays an important role in pollution management. Soil particles and mulch help trap or bind pollutants, like heavy metals and certain nutrients, through a process called adsorption. This soil mix, combined with the plant root zone, also helps support beneficial microbial communities that break down pollutants as part of their metabolism.

- Plant uptake is also a vital process contributing to pollution mitigation in your bioretention cell. Plants help remove nutrients from the soil, using and storing these in plant cells. This nutrient uptake is a benefit to the plant, as it contributes to its growth and viability, while simultaneously reducing excess dissolved nutrients in runoff.

Maintenance of Your Bioretention Cell for Long-Term Function

There are several inspection and maintenance activities your community can perform to keep your bioretention cell functioning well and to protect your community's investment. Recommendations included below are based on guidance from the *South Carolina DHEC Storm Water BMP Field Manual* (2005), the Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al., 2014), North Carolina State University Extension, and the Clemson University Cooperative Extension Service.

Inspect your cell regularly and after large storm events. Semi-annually and after major storm events, check your bioretention cell and look for signs of trash and debris, sediment accumulation, clogged inlets, or outlets and erosion. As soon as possible, pick up trash and debris and use a shovel to remove accumulated sediment. Erosion and scouring around the inlets or outlets can be a result of high velocity flows. If areas are eroding, repair and establish sod or use rock and/or special erosion-control matting to protect from further failure and slow the flow of water.

Figure 4. This parking lot bioretention cell has standing water outside of the recommended time to drain, an indicator that the cell may be clogged. Photo courtesy Bill Lord, NC State University.

Clogging is the most common failure in a bioretention cell. Clogging occurs when a layer of fine sediment accumulates along the basin of the cell, reducing the ability of the cell to infiltrate runoff. Following a storm, check for these signs of clogging in your cell:

- A cell that is taking more than three days (72 hours) to drain after rain events, and/or
- A cell that is holding water with no flow through the underdrain.

If clogging is suspected, it is recommended that you consult with a licensed engineer for further assistance.

Periodically inspect your plants for signs of disease or other concerns. Follow best recommendations for pruning trees and shrubs, and if you have turf in your bioretention cell, mow periodically to the recommended height for the type of grass present. Visit the Clemson Extension Home and Garden Information Center website (www.clemson.edu/extension/hgic/) for specific tips on maintenance for the grass or plants in your cell. If replanting is needed, look for native or well-adapted plants that can tolerate both wet and dry soil conditions. Avoid invasive plant species. Use the Carolina Yards Plant Database (www.clemson.edu/cy/plants) for recommendations.

Avoid using fertilizer and herbicides in and around your cell. Given the nature of stormwater runoff, bioretention cells typically receive the nutrients needed to support plant growth and additional fertilizer amendments are unnecessary, other than at the time of planting. If nuisance weeds appear in your cell, hand pull to remove and select plants that will work to outcompete the weeds long-term.

Only irrigate your bioretention cell during extended periods of drought or after new species are planted. As much as possible, allow rainfall and runoff to be the source of water for your bioretention cell.

Maintain a healthy 2-3" layer of mulch through reapplication. Recommended mulch for bioretention cells is triple-shredded hardwood mulch; avoid using cypress mulch, as well as pine nuggets and pine needles. Though less expensive, pine nuggets and pine needles are lightweight and easily float around the basin, potentially clogging the outlet(s). The use of these lightweight mulches is discouraged.

Figure 5. Without action to remove debris in the grate and cell, this grate may become clogged with floatable leaf litter and result in drainage problems in the bioretention cell. A new hardwood mulch layer should be established in the cell to prevent clogging, reduce exposed soils and minimize the chance of erosion. Photo courtesy Bill Lord, NCSU.

Figure 6. Steep slopes and exposed soils along this bank resulted in erosion and gullying, which can attribute to sedimentation in downstream best management practices like bioretention cells. Owners took action to repair this site by seeding the area with grass to stabilize, and installing an erosion control blanket to provide protection until grass establishes.

Stabilize upland areas. Excessive levels of accumulated sediment in your bioretention cell can result in clogging and impaired function. Stop problems before they start by working with your community to identify "hot spots" of concern upland of your bioretention cell. Look for areas that have exposed soil or signs of erosion, like gullies near driveways or gutters. To help address problem spots, try installing turf or seeding with grass, planting flowers or shrubs or mulching. Use a manufactured erosion control blanket to help with stabilization while waiting for vegetation to establish. For sites with active construction in your community, make sure that appropriate practices, such as silt fence or inlet protection, are being used to keep sediment contained and out of the storm drain and path of runoff flow. The Carolina Yards Plant Database (www.clemson.edu/cy/plants) can be used to identify appropriate plants for this best practice. Annual rye can be used for a quick-growing, though temporary, turf establishment and site protection.

Be Mindful of Our Community Impact

Stormwater best management practices address runoff from across the landscape; therefore, the impact of individuals and collectively, a neighborhood, can make a significant difference in the performance and long-term function of your stormwater treatment investment. Individual actions to reduce runoff and pollution picked up by runoff include managing erosion, applying fertilizer according to the label and only as needed, disconnecting your downspout from impervious surfaces, minimizing irrigation that leaves your property and more. Find out how to get involved in pollution prevention practices at www.clemson.edu/carolinaclear.

Additional Resources

- Help to protect water quality by mapping your community's bioretention cell at the SC Low Impact Development Atlas! By sharing what these practices look like in your region of the state, you can increase the likelihood of greater adoption of these water protection practices and greater information sharing! www.clemson.edu/public/carolinaclear/lidmap/

- To find a list of plants suitable for your bioretention cell, consult the Carolina Yards Plant Database, where you can search by region of the state and by stormwater best management practice for help on what plants will thrive in your bioretention cell. www.clemson.edu/cy/plants

References:

Ellis, K., C. Berg, S. Drescher, G. Hoffmann, B. Keppler, M. LaRocco and A. Turner. 2014. Low Impact Development in Coastal South Carolina: A Planning and Design Guide. ACE Basin and North Inlet-Winyah Bay National Estuarine Research Reserves, 462 pp.

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Hunt, W, F. Smith, S. Jadlocky, J. Hathaway, P. Eubanks. 2008. Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban Charlotte, N.C. *Journal of Environmental Engineering* 134 (5) pp.403-408.

Sources of Significant Contribution:

Clemson University Cooperative Extension Service's "Post-Construction BMP Inspector Certificate Program".

North Carolina State University's "Stormwater BMP Inspection and Maintenance Certification Program".

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